załącznik do Regulaminu programu „visiting profesor”

Osoba zgłaszająca z PW	
Tytuł i stopień naukowy	dr hab. inż., prof. uczelni
Imię i nazwisko	Robert Głębocki
Wydział	Wydział Mechaniczny Energetyki i Lotnictwa
Mail w domenie PW	Robert.Glebocki@pw.edu.pl
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Propozycja osoby zgłaszanej jako visiting professor	
Tytuł i stopień naukowy	dr hab. inż., Associate Professor
Imię i nazwisko	Serhii Larkov
Dokładna afiliacja	Institute of Aerospace Technologies of the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”
Mail kontaktowy	sergelarkov@ukr.net
Opis osiągnięć (1/2-1 strony)	Professor Serhii Larkov was born in Baikonur and spent his childhood with rockets and cosmonauts. He studied the rocket science in Kharkiv Aviation Institute (1987-1993) and worked in aerospace enterprises: Scientific Research Institute of Radio Engineering Measurements and SE Kommunar. He took part in the development, testing and manufacture of the control system units for the Soyuz, Proton and Zenith launch vehicles in all positions - from design engineer to chief technologist (1993-2011). Also he works on prospective researches in guided missile development in Kiev Design Bureau Luch (2012-2016), as a head of the department of scientific research in State Space Agency of Ukraine (till 2022) he was involved in the management of the launch vehicles and satellites projects. Now he a senior lecturer in Igor Sikorsky Kyiv Polytechnic Institute and took part in the development and testing of the university nanosats. Serhii Larkov got his PhD in 2005 in National Aerospace University on problems of the complex mathematical modeling of the working processes in air-breathing engines. His scientific interests are flight dynamics, aero- and gas dynamic processes to develop the complex mathematical models of the flying vehicles to simulate its behavior in various environments. As volunteer he involved in Ukrainian projects for the UAV development, anti-drone defense, external and impact ballistics. He published about 30 papers in referenced journals, co-author in 3 books and about ten printed conference proceedings.

Code of the course	4606-VP-ES-00026	Name of the course	Polish	Złożone modelowanie matematyczne dynamiki lotu kierowanych pocisków rakietowych
			English	Complex mathematical modeling of the guided missiles flight dynamics
Type of the course	Specialty subject			
Course coordinator	Serhii Larkov	Course teacher	Serhii Larkov	
Implementing unit		Scientific discipline / disciplines*	Mechanical Engineering/Automation, Electronics and Electrical Engineering and Space Technologies/	
Level of education	Doctoral studies	Semester	March 12, 2025 to June 12, 2025 12.03.2025 - 12.06.2025 (zdalnie)	
Language of the course	English			
Type of assessment	credit	Number of hours in a semester	60	ECTS credits: 5
Minimum number of participants	10	Maximum number of participants	30	Available for students (BSc, MSc): Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week					
	in a semester	28			28	4

* does not apply to the Researcher's Workshop

1. Prerequisites

Basic knowledge of mathematics incl. numerical methods, mechanics, automatic control theory, aerodynamics and flight dynamics, rocket propulsion. Knowledge of these issues at the engineering level.

2. Course objectives

The goal of the course is to study the methodology of creating a complex mathematical model of the flight of a guided missile and the operation of its control system.

3. Course content (separate for each type of classes)

Lecture

1. Overview of the guided missile development process and role of the mathematical modeling;
2. Tasks and software to create of the mathematical models for missiles and its subsystems;
3. Overview of the aerodynamic phenomena in the range of subsonic, transsonic and supersonic velocities
4. Missile aerodynamics peculiarities to take into account for modeling of its behavior;
5. Overview of the processes in the rocket motors and jet engines;
6. Development a models of the rocket and jet engines for quick calculation of parameters. Disturbances from the rocket motors;
7. Missile actuators: types, peculiarities and overall data. Common structure of the actuators;
8. Electrohydraulic, pneumatic and electric drives. Models of the actuator components and subsystems;
9. Warheads and its modeling. Target hit criteria;
10. Guided missiles classification and guidance laws;
11. Missile dynamics: governing equations;
12. Modeling of navigation, guidance and control systems. HIL models requirements;
13. Seekers and its modeling;
14. Visualization of calculation results and comparison with data from flight tests;

Laboratory

1. Calculation of the drag force coefficient using manual approach;
2. Modeling of aerodynamic characteristics by means of MissileDATCOM;

3. Development of a aerodynamics subsystem of the complex model in Matlab/Simulink;
4. Actuator parameters identification using experimental data. Development the phenomenological model of the actuator subsystem;
5. SRM propellant grain burning modeling;
6. Development of a rocket engine model with thrust vector control/disturbances;
7. Electric driven actuator modeling: from BLDC and gearbox parameters to servo model;
8. Pneumatic actuator with jet pipe amplifier and piston drive modeling;
9. Blast fragmentation warhead design and optimization for anti-drone use;
10. Join the Matlab/Simulink and Flightgear. Target kinematics modeling and visualization;
11. Matlab/Simulink flight dynamics modeling using aerodynamics subsystem from WS3;
12. Development a Matlab/Simulink models of the operation of the navigation, guidance and the control systems;
13. Three-point guidance system modeling;
14. SAM complex model integration and testing. Determination the miss distance;

Seminar

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	Knowledge of the role of the mathematic modeling in the development cycle of the guided missiles.	SD_W1	written test
K02	Knowledge of individual subsystems of guided missiles and rules to create their models. Knowledge of the impact of individual subsystems characteristics on the functioning of the entire system with guided missile	SD_W2	written test
K03	Knowledge on the pathway to determine the integral characteristics of the system with guided missile by Monte Carlo method	CD_W3	written test
Skills			
S01	Ability to include the model development in the design process of the system with guided missile.	SD_U1	project evaluation
S02	Ability to formalize design requirements and create mathematical models of guided missile subsystems on base of incomplete information of the initial design stage	SD_U2 SD_U4	project evaluation
S03	The ability to plan a numerical experiment to obtain integral characteristics	SD_U6 SD_U7	project evaluation
Social competences			
SC01	Competence in leading the engineering teams	SD_K1, SD_K2 SDK4	Written test

*Allowed learning outcomes verification methods: exam; oral exam; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

Project evaluation and oral test

6. Literature

Primary references:

[1] Eugene L. Fleeman, “Tactical Missile Design”, American Institute of Aeronautics & Astronautics, 2022, ISBN: 9781624106187
[2] Paul Zarchan, “Tactical and Strategic Missile Guidance”, American Institute of Aeronautics & Astronautics, 2019, ISBN: 9781624105845
[3] Siouris, George M. Missile guidance and control systems / George M. Siouris. Springer-Verlag New York, Inc, 2004, ISBN 0-387-00726-1

Secondary references:

[1] Yanushevsky, Rafael. Modern missile guidance / Rafael Yanushevsky. CRC Press, 2008, ISBN: 1-4200-6226-3

[2] Advances in Missile Guidance, Control, and Estimation / editors, S.N.Balakrishnan, A.Tsourdos, B.A.White. CRC Press, 2013, ISBN 978-1-4200-8313-2

7. PhD student’s workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	56
2	Hours of consultations with the academic teacher, exams, tests, etc.	4
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	56
4	Amount of time devoted to the preparation for exams, test, assessments	10
	Total number of hours	126
	ECTS credits	5

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	2
Number of ECTS credits earned by a student in a practical course	1